Division of Environmental Chemistry
- Hydrospheric Environment Analytical Chemistry -

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Scope of Research

Research activities are concerned with geochemistry, oceanography, limnology and analytical chemistry, which are important basic sciences in order to realize the sustainable society. Major research subjects are as follows: (i) Biogeochemistry of trace elements in the hydrosphere. (ii) Hydrothermal activity and deep biosphere on the ocean floor. (iii) Fe-uptake mechanism of phytoplankton. (iv) Ion recognition. (v) Simulation of non-linear chemical reaction.

Research Activities (Year 2005)

Presentations

Determination of Chromium, Copper and Lead in River Water by Graphite-Furnace Atomic Absorption Spectrometry after Coprecipitation with Terbium Hydroxide, Minami T, Sohrin Y, Ueda J, The 54th Annual Meeting of the Japan Society for Analytical Chemistry, 15 September 2005.

Determination of Dissolved Zr, Hf, Nb, Ta and W in the North Pacific Ocean, Firdaus M L, Norisuye K, Sohrin Y, The 52nd Annual Meeting of the Geochemical Society of Japan, 26 September 2005.

Trace Metals and Biological Processes in the Ocean, Norisuye K, Sohrin Y, The 2005 Fall Meeting of the Oceanographic Society of Japan, 1 October 2005.

Geochemistry of Bioactive Trace Metals during an *In-situ* Iron Enrichment in the Subarctic Western North Pacific Gyre (SEEDS II), Nakatsuka S, Nishioka J, Kinugasa M, Sohrin Y, SEEDS II Workshop Second Iron Enrichment Experiment in the Western Subarctic Pacific, 17 October 2005.

Hydrothermal Plumes at the Myojinsho Submarine Caldera, the Shicitio-Iwojima Ridge, Izu-Bonin Arc, Okamura K, Toki T, Hyun K S, American Geophysical Union Fall Meeting 2005, 9 December 2005.

Selective Separation of Zn(II) and Cd(II) Using Nitrogen Containing Macrocyclic Ligands as Ion-Size Selective Masking Reagents, Kurahashi K, Taguchi Y, Umetani S, Sohrin Y, Pacifichem 2005, 17 December 2005.

Molecularly Imprinted Sol-Gel Materials for the Separation of Metal Ions, Taguchi Y, Kurahashi K, Umetani S, Sohrin Y, Pacifichem 2005, 17 December 2005.

Grants

Sohrin Y, Interaction between Metallome and Proteome in the Marine Ecosystem, Grant-in-Aid for Scientific Research (A) (2), 1 April 2004 - 31 March 2007.

Okamura K, Development of Time-series Measurement System of Sulfur Related Matter in Seawater, Grant-in-Aid for Young Scientists B, 1 April 2003 - 31 March 2006.

Okamura K, Transportation of Trace Heavy Metal to Natural Water from Exhaust Gas, Nissan Science Foundation, 1 April 2005 - 31 March 2006.

Topics

Geochemistry of Bioactive Trace Metals during the Mesoscale Iron Enrichment in the Subarctic Western North Pacific Gyre (SEEDS I and II)

The equatorial Pacific, the North Pacific and the Southern Ocean are well known as high-nutrient low-chlorophyll (HNLC) regions, where phytoplankton biomass is low (<1 μg Chl *a* l^{-1}) despite abundance of macronutrients (NO_3^-, PO_4^{3-}, $Si(OH)_4$). In most HNLC waters, low concentration of dissolved iron (<0.22 μm) was identified, using extremely careful sampling and analytical techniques. Iron has been invoked as a limiting factor to primary production (iron hypothesis) due to its biological requirement, together with light-limitation, grazing effect by zooplankton and water temperature. Recently, the iron hypothesis is evidenced by the fact that a number of mesoscale iron enrichment resulted in a rapid accumulation of phytoplankton biomass. We have been investigated the marine geochemistry of Fe, Co, Ni, Cu, Zn and Cd, which have many implications for phytoplankton's growth and metabolic processes, during the mesoscale iron enrichment in the Subarctic Western North Pacific Gyre (SEEDS I and II: in the cruise of Hakuho-Maru, Fig. 1).

Figure 1. Hakuho-Maru; the research vessel used for the observation during SEEDS I and II.

SEEDS I and II have been conducted in 2001 and 2004, respectively. Although both experiments showed increase in primary production, the effect was very different: SEEDS I resulted in a massive increase in biomass (20 μg/kg of Chl *a*) with floristic shift to fast-growing centric diatom *Chaetoceros debilis*, whereas the response in SEEDS II was much less significant (~3 μg/kg of Chl *a*) with domination of Pennate diatom *Pseudo Nitzschia*. High density of mesozooplankton biomass (*copepod*) was also observed in SEEDS II. During SEEDS II, bottle incubation was conducted using ambient seawater, from which mesozooplankton was removed. The bottle incubation revealed that addition of iron (1 nM) triggered increase in Chl *a* up to ~9 μg/kg, shown in Fig. 2.

In SEEDS I (for 13 days), the concentration of dissolved Co, Ni, Cu, Zn and Cd decreased by 0.03, 0.7, 0.4, 1.3 and 0.06 nM, respectively, following development of the bloom. It was the first observation that Co, Ni, Cu and Zn decreased by the iron enrichment. Compared to SEEDS I, SEEDS II (for 32 days) exhibited a quite different response. There was no major decrease in the concentration of trace metals except for Cd (~0.2 nM). In contrast, the concentration of trace metals during the bottle incubation showed significant decreases in dissolved Zn (~0.3 nM) and Cd (~0.2 nM). The variations of trace metals are shown in Fig. 3.

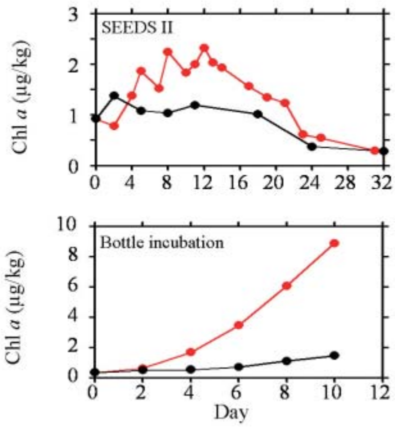

Figure 2. The increase in Chl *a* during SEEDS II and bottle incubation. The red symbol with solid line and the black one indicate the iron enriched and ambient seawater, respectively.

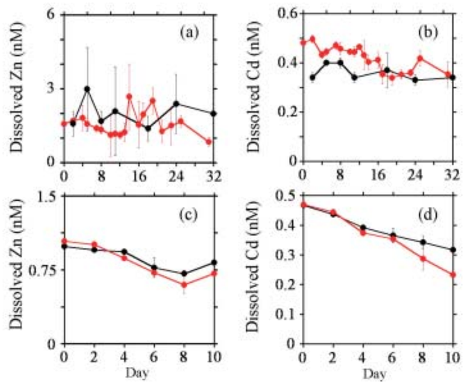

Figure 3. The variation of the trace metals in surface mixed layer during SEEDS II (a and b) and the bottle incubation (c and d). The red symbol with solid line and black one indicate the iron-enriched sea water and the bottles received iron, respectively.

On the basis of the iron enrichment and the bottle incubation, it can be concluded that phytoplankton plays a primary roll in controlling the concentration of trace metals through active uptake in the ocean. Zooplankton also appears to be controlling the concentration of trace metals indirectly, through the grazing effect on phytoplankton.